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# Infrastructure Elements of a Viable Cycling Network in the United States

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The number of drivers on the road in the U.S. has been steadily increasing since the automobile became a popular mode of transportation in the early 1900s. The growth of car popularity has caused a drastic increase in traffic congestion and vehicle-related accidents; the growth in automobile use is also putting an unplanned amount of stress on the nation's infrastructure, causing deterioration to be far more rapid than was expected (Small, 1997). In Germany and the Netherlands, the response to increasing car traffic has been to alleviate it by encouraging use of bicycles and has seen widespread success (Pucher and Buehler, 2008b). This convenient and relatively cheap method of transportation can provide transportation to young and indigent people, reduce traffic congestion, alleviate pollution, and decrease annual wear on roads. However, the U.S. has safety and convenience limitations that prevent bikes from being practical for any use except leisure. People most frequently respond on surveys that safety concerns and inconvenience prevent them from biking (Langone-Danila and Fink, 2013). Proximity to vehicles on roadways and intersection design issues contribute most to hazardous conditions for cyclists. For the U.S. to ever become a biking nation, these risk factors must be addressed. Improving and expanding cycling infrastructure would make biking a viable transportation option in the U.S. In countries where cycling is popular for commuting, adequately developed infrastructure is the key element of their systems. Bike lanes and intersection alterations are the two main biking facilities that are most influential. By taking these two factors into consideration and making a bike network priority, the U.S. could see a huge increase in the number of cyclists on the road.



## Introduction

The number of drivers on the road in the U.S. has been steadily increasing since the automobile became a popular mode of transportation in the early 1900s. From 1969 to 2009, the number of miles traveled annually increased from 1.4 to 3.7 trillion (Santos et al., 2011). Results of the 2001 household traffic survey indicate that 87% of all daily trips were in a personal vehicle (USDOT, 2003). The growth of car popularity has caused a dramatic increase in traffic congestion and vehicle-related accidents. Between 1983 and 2001, the average commuter distance traveled has not changed appreciably; however, the average travel time has increased by 6 minutes due to increasing traffic volume (USDOT, 2006). Americans sit in traffic 4.2 billion hours every year (TRIP, 2009). The growth in automobile use is also putting an unplanned amount of stress on the nation's infrastructure, causing deterioration to be far more rapid than was expected (Small, 1997). In Germany and the Netherlands, the response to increasing car traffic has been to alleviate it by encouraging use of bicycles and has seen widespread success (Pucher and Buehler, 2008b). While only 1-3% of American trips are on bicycle, they represent up to 27% of trips in Germany and the Netherlands (Langone-Danila and Fink, 2013). These countries provide a wide variety of cycling programs, convenient access to public transit, and broad, well-developed bike networks (Shaheen et al., 2010); (Pucher and Buehler, 2008a). This convenient and relatively cheap method of transportation can provide transportation to young and indigent people, reduce traffic congestion, alleviate pollution, and decrease annual wear on roads. However, the U.S. has safety and convenience limitations that prevent bikes from being practical for any use except leisure. People most frequently respond on surveys that safety concerns and inconvenience prevent them from biking (Langone-Danila and Fink, 2013). Proximity to vehicles on roadways and intersection design issues contribute most to hazardous conditions for cyclists. For the U.S. to ever become a biking nation, these risk factors must be addressed. Developing a widespread bike network of safe cycling infrastructure would make biking a viable transportation option in the U.S.

## Cycling Infrastructure

Improvement of cycling infrastructure is crucial for developing a biking network. The popularity of cycling is mostly limited to cities with biking facilities in place. Portland, Oregon has the highest bike use and also has the most developed biking facilities of any American city (Pucher et al., 2011). However, despite the fact that 6% of Portland's citizens commute by bike, the majority of the adult population still cites safety hazards as the main deterrent for biking (Dill et al., 2012). In a survey in 1995, 20% of commuters indicated that they would bike more frequently if better and more ample cycling infrastructure was provided (ODOT, 1995). These data indicate that cycling facilities are necessary for encouraging biking. Figure 1 illustrates one reason behind the relationship between cycling facilities and biking popularity— safety. The figure plots kilometers biked versus the number of cyclists deaths annually between 1950 and 2005. A corollary between the safety and the popularity of cycling is evident; when roads are safer for cyclists, more people choose to commute by bike. The development of infrastructure that improves the safety of biking thus encourages people to bike. Separation between cyclists and car traffic is the key factor in improving safety (McNeil, 2011). Bike lanes, bike pathways, and intersection alterations are the major infrastructure developments necessary to provide adequate separation.



Source: Netherlands Ministry of Transport (2007)

Figure 1. The graph shows the inverse relationship between bike use and cyclists killed in the Netherlands (Pucher and Buehler, 2008b).

### Bike Lanes and Paths

With separation being the key factor for cyclist safety, more road space allotted to bikes and designated bike lanes are crucial for a successful cycling network. There are multiple methods to create space for cyclists on roads with varying degrees of separation: wider lanes with narrower on-street parking, brightly painted bike lanes, and cycle tracks.

The first, and least preferable, option for cyclists is wider roads where cars and bikes share the lane. Wider lanes give cyclists space to the right of the lane and allow motorists to pass them on the left. Where limited right-of-way prevents widening roads as a redesign option, narrowing on-street parking is a potential solution for still providing a buffer zone for bikes. Figure 2 illustrates the correlation between parking lane widths and the distribution of parking distance from the curb. As the width of the parking lane increases, more people park farther away from the curb. For every extra foot of parking lane width, drivers parked on average 3.7 inches farther from the curb. The implication of this data is that narrowing parking spaces forces drivers closer to the curb. It would provide an easy way to allow more space for cyclists without having to make streets any wider. By reducing parking lanes from 8 feet to 7 feet and increasing the travel lane width by a foot, an extra foot and 3.7 inches could be reallocated to cycling space. The issue here is that unless clearly marked, cars in the parking and travel lanes will encroach on cyclist space (Furth et al., 2010). Narrowing parking space and clearly marking the division between driving, biking, and parking lanes would create safer cycling space. In addition to narrowing parking, travel lane widths can safely be lowered to ten feet in 25 mph and eleven feet in 30 to 40 mph zones to reallocate lane space to cyclists (ODOT, 1995). A combination of narrower parallel parking and travel lanes can provide up to three feet of buffer zone for bikes.

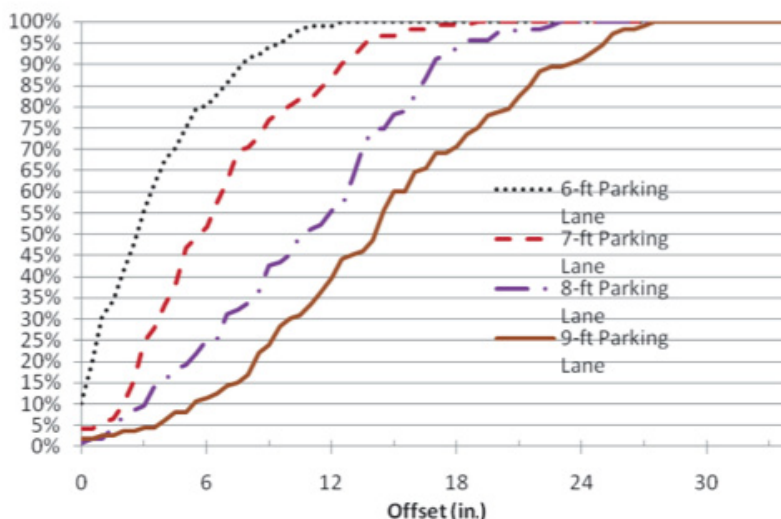


Figure 2. The graph shows how far from the curb people park in varying lane widths (Furth et al., 2010).

However, even with wider lanes and a larger buffer zone, motor vehicles still present various hazards to cyclists with this road design. These safety concerns include cars passing cyclists tending to encroach into other lanes of traffic, frequently illegally turning right in front of cyclists after passing them, and failing to properly yield to bikes. In addition, cyclists create unsafe conditions for themselves by more frequently riding on sidewalks, failing to obey stop signs, and making improper turns at intersections (USDOT, 1999). The alternate, safer design option for cyclists is bike lanes.

Designated bike lanes provide space for cyclists to ride on-street without being directly in the flow of car traffic. They provide separation from motor vehicles by creating a visual and psychological buffer zone (Furth et al., 2010). A bike lane width of six feet is desirable because it provides adequate separation from car traffic while still allowing cyclists to operate far enough away from the curb to increase their visibility to drivers. Another option is a raised bike lane with a sloped curb that allows cyclists to enter and exit the lane when necessary (ODOT, 1995). The raised lane also alerts drivers when they have encroached on the bike lane, providing a physical separation in addition to the psychological and visual buffer of the painted lane. A survey conducted in 2003 indicates a direct relationship exists between the prevalence of bike lanes and the usage of bikes. In 42 large cities where cycling infrastructure is most common, data taken on commuting habits show that every mile of bike lane or path added per square mile results in approximately a 1% increase in the number of cyclists (Dill and Carr, 2003). This increase is due in large part to people's perception of their safety while cycling. A study was conducted in New York City before and after the addition of bike lanes to evaluate actual cyclist safety with bike lanes. As well as increasing cycling popularity, the number of vehicle-bicycle crashes midblock and at intersections was significantly reduced by the bike lanes (Chen et al., 2012). By incorporating more bike lanes into road plans, cities could thus greatly encourage cycling by improving safety perceptions and conditions.

Several cities in the U.S., including New York City and Portland, have started painting a portion of new bike lanes in bright colors like red, green, and blue (Pucher et al., 2011). Although more space or a physical barrier between cyclists and car is preferable, the colors make the cyclists more noticeable and the painted lane creates more of a visual barrier. Having color-coded painted directions for bikers helps reduce the interactions between cyclists and cars caused by confusion (Pucher and Buehler, 2008a). Implementing this method in road construction projects where narrow right-of-ways limit the width of lanes would still allow for

a larger degree of separation than vaguely marked bike lanes.

Although standard bike lanes are most commonly used, cycle tracks provide more separation by having a curb or other barrier between motor and bike traffic (Pucher et al., 2011). The barrier presents an alternative method of creating a buffer and designating a cycling lane where vehicle speeds and high traffic volumes create a more hazardous biking environment. Creating an actual physical barrier between cars and cyclists protects the integrity of the cycling lane and prevents vehicles from entering that space. This method would be preferable over standard painted bike lanes for high speed and volume collector and arterial roadways.

### **Bike Pathways**

Multi-use pathways are a popular alternative to on-street biking facilities. As seen in Germany and the Netherlands, a system of separate cycling paths is the most important infrastructure feature to make cycling a safe and popular transportation alternative (Pucher and Buehler, 2008a). They are entirely separate routes for bikes and, thus, provide the greatest separation from car traffic. The same as with bike lanes, a direct relationship between the number of cyclists and the number of bike pathways in a city exists, indicating that this design feature does encourage biking. As a whole, cyclists prefer separate pathways to sharing the road with cars even if it adds distance to their trips (Pucher et al., 2011). However, having the pathways close to common thoroughfares would be the most effective way to encourage use. Although the higher separation from cars does improve safety, convenience is an important factor in Americans' choices of what mode of transportation to use.

### **Intersection Alterations**

Bike lanes and pathways are not enough to provide adequate safety at intersections; collisions between cyclists and drivers turning right are among the most common bike-car impacts (Dill et al., 2012). Sixty percent of conflicts occurred between motorists and cyclists going in the same direction, rather than cross-street conflicts. In addition, left hand turns are still extremely problematic and dangerous for bikes (USDOT, 1999). These trends indicate problems with visual awareness or illegal maneuvers. Having a bike box, otherwise known as an advanced stop line for cyclists, 3 to 5 meters ahead of the queue of vehicles makes cyclists more visible to drivers and therefore safer (Pucher et al., 2011). This safety feature would be particularly crucial for addressing visual awareness issues at large, high-traffic intersections. The more cars that pass through an intersection, the more likely it is for a cyclist to not be noticed and be struck. The bike boxes also could reduce the number of collisions between cyclists crossing the intersection and cars turning right. Having the cyclists in front of the right lane of traffic, as shown in Figure 3, would allow them to safely cross before cars could turn right. To address the issue of illegal maneuvers by both cyclists and drivers, brightly painting the bike boxes encourages both parties to obey laws and not encroach on the other's lane (USDOT, 1999). Data show that 77% of cyclists perceive bike boxes as being safer and, indeed, bike boxes do reduce vehicle-cycle conflicts by approximately 30% even with a significant increase in the number of bikes on the road (Dill et al., 2012). Solving the infrastructure safety issues at intersections and addressing people's perception of them is critical to increasing cycling's popularity. Well-designed bike boxes achieve both goals.

A frequent cause of crashes at signalized intersections is cyclists illegally crossing at red lights. There are two main causes of this behavior; the delay of sitting at red lights is inconvenient and bikes often aren't able to trip the inductive loop sensors that are calibrated to cars (Johnson et al., 2013). Loop sensors, calibrated for bikes, farther back in the bike lane would detect approaching cyclists and extend the green light by a few seconds (ODOT, 1995). This design feature minimizes unnecessary delays for cyclist and prevents potential red light infringement caused by inconvenience and impatience. In addition, properly calibrated inductive loop detectors or conveniently located push-buttons would allow cyclists to trip the light instead of waiting for a vehicle to do it. Painting a symbol in the bike lane to indicate to cyclists where

to wait in order to trip the signal would increase the effectiveness of this design even more (Langone-Danila and Fink, 2013). Installing properly functional loop detectors would largely prevent red light infringement.

Another potential modification is the addition of advance green lights for bikers (Pucher and Buehler, 2008b). Preventing cars and bikes from crossing intersections simultaneously eliminates another vehicle-cyclist interaction. Each one of these interactions that is eradicated from the system makes cycling a safer and more viable option.

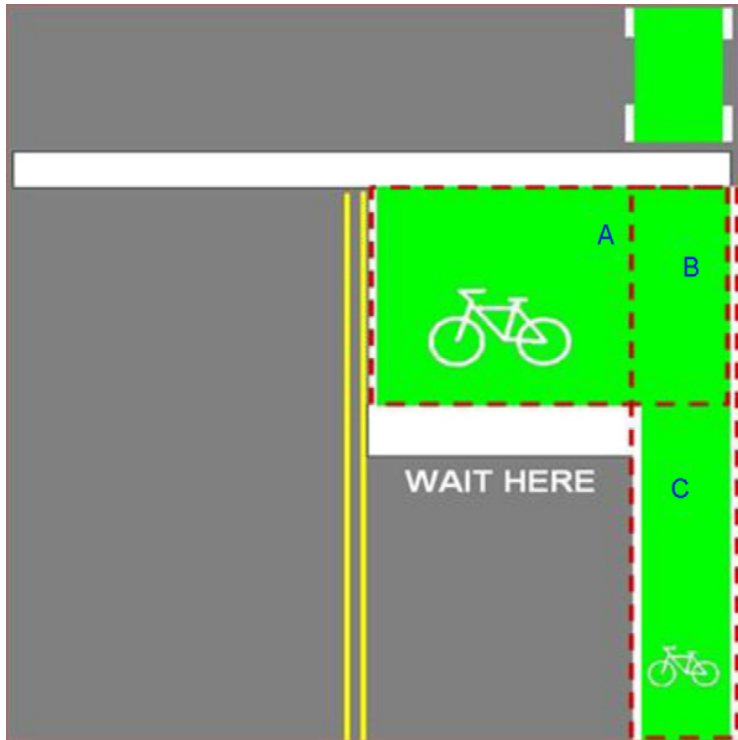


Figure 3. The bike box allows cyclists to be in front of cars stopped at intersections (Dill et al., 2012).

## Conclusion

Simple changes in the way transportation design is approached would have a marked effect on taking cycling from leisure activity to practical transportation. Lack of cycling infrastructure is the largest hurdle that the U.S. currently faces in making cycling viable. People in American cities perceive cycling conditions as being unsafe and inconvenient due to lack of developed biking facilities. In countries such as Germany and the Netherlands where cycling is popular for commuting, the key element of their systems is well-planned and developed biking infrastructure. Bike lanes and intersection alterations have the most potential to influence cycling's popularity by improving actual safety and people's perceptions of their safety. By taking these factors into consideration and making a bike network priority, the U.S. could see a drastic increase in the number of cyclists on the road and begin to address the issues of pollution, congestion, and excessive roadway maintenance.



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